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The Salivary Pump in the Taxonomy of the *Coccinea* (*Homoptera*)

(Pp. 263—290, 11 text-figs.)

Pompa ślinowa w taksonomii czerwców (*Coccinea, Homoptera*)

Слюнной насос в таксономии червецов (*Coccinea, Homoptera*)

Abstract. The cuticular skeleton of the salivary pump, including salivary ducts, is described in major groups of *Coccinea*. The evolution of the pump and its significance in the taxonomy of the scale insects are discussed.

INTRODUCTION

The comparative investigations on the mouthparts in the *Coccinea*, initiated with the researches on the labium (Koteja, 1974) are continued in this paper. In contrast with the labium and clypeolabral shield (the latter will be published in a separate paper), the salivary pump has never been respected in the taxonomy of the *Coccinea*. A few papers dealing with the salivary pump (Stickney, 1934; Pesson, 1944) discuss only the morphological structure and function of this organ.

The salivary pump has been studied on the same material as the labium with the use of similar methods, both presented in detail in the earlier paper (Koteja, 1974). This paper contains also a general introduction to the question. The taxonomic conclusions arising from the studies on the mouthparts are discussed separately (Koteja, 1974 a).

The length of the pump has been measured from the margin of its inner end to the outlet of the tube in the column. The size of the pump is calcula-

ted as $S = \sqrt{l \cdot w}$, where l and w represent the length and width of the pump. The relative sizes of the pump are presented as

$$RP = \frac{100\ S}{\sqrt{l_1 . w_1}} \quad \text{and} \quad RC = \frac{100\ S}{\sqrt{l_2 . w_2}}$$

where RP and RC represent the size of the salivary pump in relation to the pharynx and clypeolabral shield, respectively, l_1 and l_2 the lengths of the pharynx and clypeolabral shield, and w_1, w_2 the widths of these structures.

All data presented in this paper, if not otherwise stated, refer to the adult female. Similarly, the figures of the salivary pump present its dorsal surface (in topographical meaning).

GENERAL CHARACTERISTICS

The salivary pump in the *Coccinea* is typical of the *Hemiptera*. Owing to the opisthognatous structure of the head in this group the pump is well visible from the dorsal surface. It represents a cup-shaped organ situated on the tip of the hypopharynx. The column of the pump (*co*), being very strong, encloses the outlet tube (*sc*) through which the salivary liquid is expelled from the pump chamber (*cd*) to the exterior. The lateral wall (*lw*) which forms the cylinder of the pump, is usually strongly sclerotized. The wider, inner end of the pump is invaginated, to a lesser or greater degree, to the pump chamber (cylinder) and forms the piston (*ps*) of the pump. The wall of the piston is membranous and sometimes difficult to be detected on the preparations made for taxonomic purpose. To this membrane an apodeme (*ap*) is attached on which large muscles are inserted. Two main salivary ducts (*msd*) each ramified, as a rule, into three arms (*bsd*), unite into a common duct (*csd*) which joins the lateral wall of the salivary pump, dorsally (in the topographical meaning). The vulvar flaps (*v*), one by the entrance of the common salivary duct, the other by the outlet tube, were difficult to observe in the examined material. Beside the above described structures, in some groups of the *Coccinea* there exist three small projections situated on the common salivary duct between its very base and the lateral wall of the pump. The paired lateral projections (*wp*) demonstrate a wing-like shape. The unpaired medial one (*up*) is situated near the inner end of the pump. On the ventral face of the pump occurs in some species an oval, sometimes bilobed scale-like plate. The nature of the mentioned structures is unknown to the author.

The size and shape of the column vary in the groups of the *Coccinea*. In some families (*Coelostomidiidae*, *Kermesidae*) it is much longer than the cylinder, in others (*Conchaspididae*, *Asterolecaniidae*, *Diaspididae*) significantly

shorter than the cylinder. In the majority of groups the lengths of the two elements are subequal. The width of the column is small in some groups (*Ortheziidae*), large in others (*Coelostomidiidae*), or, in the majority of scale insects about half that of the cylinder.

The cylinder of the pump is usually spherical, in some groups (*Kermes*) somewhat elongated, or compressed (*Callococcus*). The lateral wall of the cylinder is sclerotized to a lesser or greater degree. In some groups (*Diaspididae*) it is covered with a characteristic sculpture.

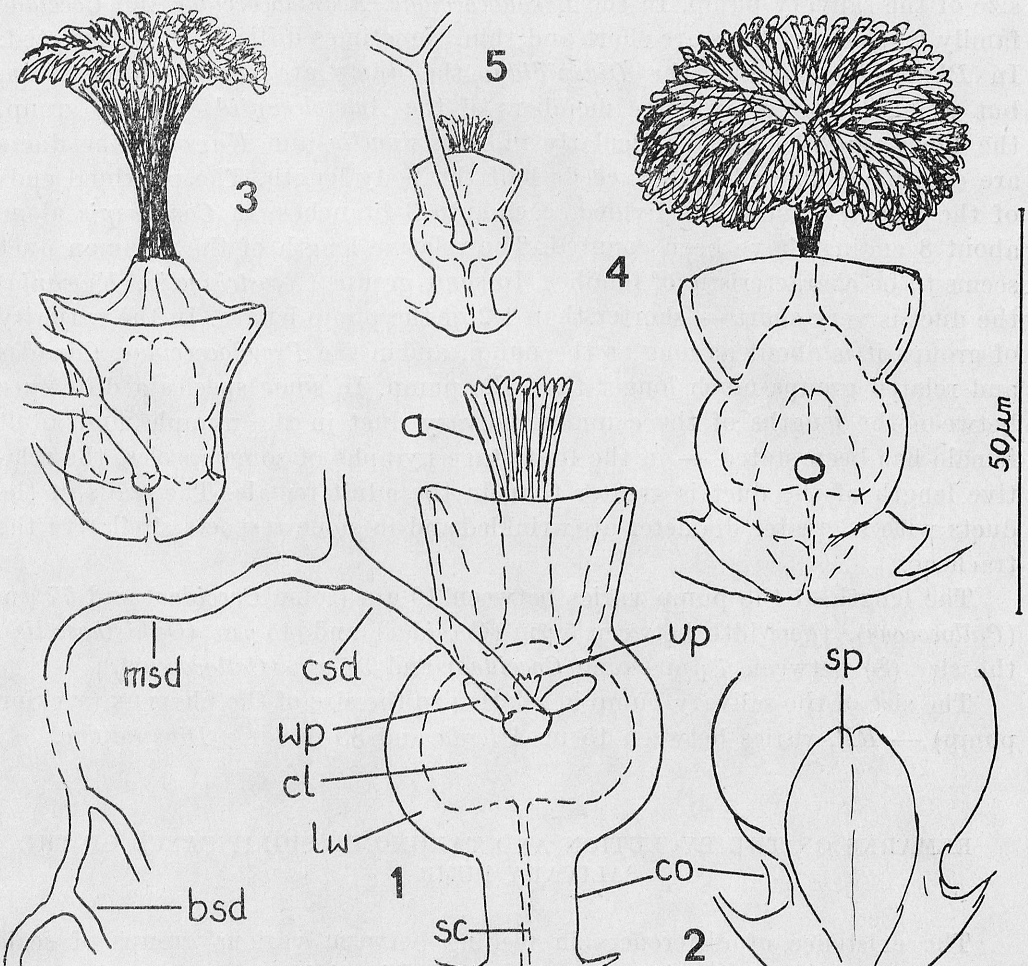


Fig. 1. 1 — Generalized figure of the salivary pump, dorsal view; 2 — Scale-like plate on the basal part of the salivary pump, ventral view; 3 — *Conchaspis angraeci*: 4 — *C. lata*; 5 — *Fagisuga trilobata*. ap — apodeme, bsd — terminal branches of the salivary ducts, cl — cylinder of the salivary pump, co — column of the salivary pump, csd — common salivary duct, lw — lateral wall, msd — main salivary ducts, sc — salivary canal, sp — scale-like plate, up — unpaired process, wp — wing-like processes

The size and shape of the piston apodeme depend on the muscles attached In the majority of groups it is small, club-shaped. In some groups (*Matsucoccus, Diaspididae,* some members of the *Asterolecaniidae* family group) the apex of the apodeme is divided into some thin, sclerotized filaments. Sometimes the paired character of the muscles is clearly demonstrated by the arrangement of the filaments (*Trichococcus napiformis*). In *Orthezia, Neosteingelia,* and particularly in the *Conchaspididae* the apex of the apodeme becomes enormous and the whole structure is fungiform.

The size of the salivary ducts is to some degree in accordance with the size of the salivary pump. In the *Pseudococcidae, Acanthococcidae* and *Coccidae* family groups the ducts are short and thin, sometimes difficult to be detected. In *Phenacoleachia,* and the *Diaspididae* the ducts are comparatively thin, but well sclerotized. In some members of the *Asterolecaniidae* family group, the *Conchaspididae* and particularly in *Neosteingelia* and *Kuwania* the ducts are enormous. Their length exceeds half the body length. The proximal ends of the salivary ducts are divided, each into 3 branches, in *Conchaspis* alone about 8 endings have been counted. The relative length of the common duct seems to be characteristic of families. In some groups (*Neosteingelia, Kuwania*) the duct is very short — shorter than 1/2 of the pump length. In the majority of groups it is about as long as the pump, and in the *Pseudococcidae, Coccidae* and related groups much longer than the pump. In some species a difference between the lengths of the common salivary duct in the nymphs and adult female has been stated — in the first stage nymphs of some species, the relative length of the duct is greater than in the adult female. The walls of the ducts with a greater diameter are wrinkled and in some respects similar to the tracheae.

The length of the pump varies between 10 μm (some *Coccidae*) and 77 μm (*Callococcus*), the width between 5 μm (*Coccidae*) and 45 μm (*Ophisthoscelis*), the size (S) between 7 μm (some *Coccidae*) and 57 μm (*Callococcus*).

The size of the salivary pump in relation to the size of the pharynx (sucking pump) — *RP*, varies between 15 in *Aclerda* and 88 in some *Diaspididae.*

REMARKS ON THE EVOLUTION AND TAXONOMIC SIGNIFICANCE OF THE SALIVARY PUMP

The existence of differences in feeding between various groups of scale insects, e. g., the *Ortheziidae, Coccidae* and *Diaspididae,* seems to be quite obvious, but comparative physiological investigations on this problem were not carried out. In this situation it is not easy to understand the significance of the salivary pump in the adaptative processes and specialization of the feeding mechanism and only some suggestions can be presented here.

The differences concerning both absolute and relative sizes of the pump between various groups of *Coccinea* are most striking (Figs 10 and 11). The

large pump and large salivary ducts indicate that a large amount of liquid is discharged. On the other hand, it is true that the effectiveness of a pump depends not only on its capacity, but also on other features, e. g. on the frequency of the piston movement. Furthermore, the diameter and length of the salivary canal in the piercing stylets, the type of the host tissue from which the food is taken, and others, should be respected in commenting upon the evolution of the salivary pump. In any case, a large pump has been stated in the members of the *Diaspididae*, *Asterolecaniidae*, *Conchaspididae* and *Porphyrophoridae* family groups and in *Neosteingelia*. These groups are regarded as being highly specialized in many respects and, therefore, it can be supposed that the enlargement of the pump represents a progressive phenomenon. Not in accordance with this rule are the conditions in the *Coccidae* family group. This group contains many specialized forms but the salivary pump remains always small.

On the ground of taxonomy the characters of the salivary pump can be utilized only to distinguish groups of higher categories. Following features are supposed to represent some value for the taxonomy: the absolute and relative sizes of the pump, its shape, the structure of the lateral wall, the size and shape of the apodeme, the size of the salivary ducts, the relative size of the common salivary duct, the presence and shape of the projections on the base of the common duct as well as the plate on the ventral side of the pump. By means of these characters the *Diaspididae*, *Asterolecaniidae*, *Kermesidae*, *Conchaspididae*, *Coelostomidiidae* and other small and specialized groups can be distinguished. In the *Pseudococcidae*, *Acanthococcidae* and all groups associated in the *Coccidae* family group, i.e., in the scale insects which form the main core in the recent fauna the salivary pump is uniform and comparatively small.

CHARACTERISTICS OF THE SALIVARY PUMP IN THE MAJOR GROUPS OF *COCCINEA*

Orthezioidea

Phenacoleachiidae

(Fig. 2)

Material examined: *Phenacoleachia zealandica*, ♀ *.

The salivary pump in this group is large: length 46 µm, width 24 µm, *S* 33 µm. In comparison with the body size and the size of other mouth parts — rather small (*RC* — 7, *RP* — 34). The width/length ratio is about 1:1,9. In dorsal view the cylinder is rounded, the column very strong, about as long

* The collecting data, authors of specific names and other references are given in an earlier paper (Koteja, 1974).

as the cylinder. The lateral wall is thick, not covered with sculpture. The apophysis is funnel-shaped, of medium size. The salivary ducts are comparatively thin, well sclerotized, about as long as the clypeolabral shield, the common duct is shorter than half of the pump length. The wing-like processes on the base of the common duct are present, the unpaired process is distinct.

Ortheziidae

(Fig. 2)

Material examined: *Arctorthezia* (2 species), *Orthezia* (2 species), *Newsteadia floccosa*, ♀ and nymphs, *Ortheziola vejdovskyi*, ♀ and nymphs.

The structure of the mouthparts makes the examination of the salivary pump very laborious in this group. The pump is large: length 16—36 µm, width 8—26 µm, *S* 12—31 µm; relative sizes: *RP* — 35—39, *RC* — 9—19. Width/length ratio — 1:1.4—1:2.2. The column of the pump is long, the lateral wall rather thin. The apophysis is apically broadened (*Arctorthezia pseudoccidentalis*) or parallelsided (*Ortheziola vejdovskyi*). The salivary ducts are small or medium sized. The common duct is longer than the length of the pump.

Monophlebidae

(Fig. 2)

Material examined: *Drosicha* (2 species), *Gueriniella serratulae*, ♀, *Gigantococcus maximus* (only first stage nymphs), *Pseudaspidoproctus armeniaca*, ♀, *Icerya purchasi*, ♀ and first stage nymphs.

The salivary pump is large: length 27—48 µm, width 16—22 µm, *S* — 20—30 µm, relative sizes: *RC* — 14—19. Width/length ratio — 1:1.7—1:2.1. The column of the pump is long, relatively narrow. The lateral wall is thin, weakly sclerotized. The apophysis is fountain-like, or fungiform. The salivary ducts are thin and long, the common duct is about as long as the pump, in the adult female (*Icerya purchasi*) relatively shorter than in the first instar nymphs. No processes occur on the base of the common duct.

Coelostomidiidae

(Fig. 2)

Material examined: Nymphs of *Marchalina hellenica* and two species of *Coelostomidia*.

The pump is long and narrow: length 29—36 µm, width about 17 µm, *S* — 22—25 µm, width/length ratio 1:1.7—1:2.5, relative sizes small: *RP* 14—19. The column of the pump is long and strong. The lateral wall is thick, the cylinder chamber small. The apophysis is club-shaped. The salivary ducts are narrow, long, the common duct is about as long as the pump.

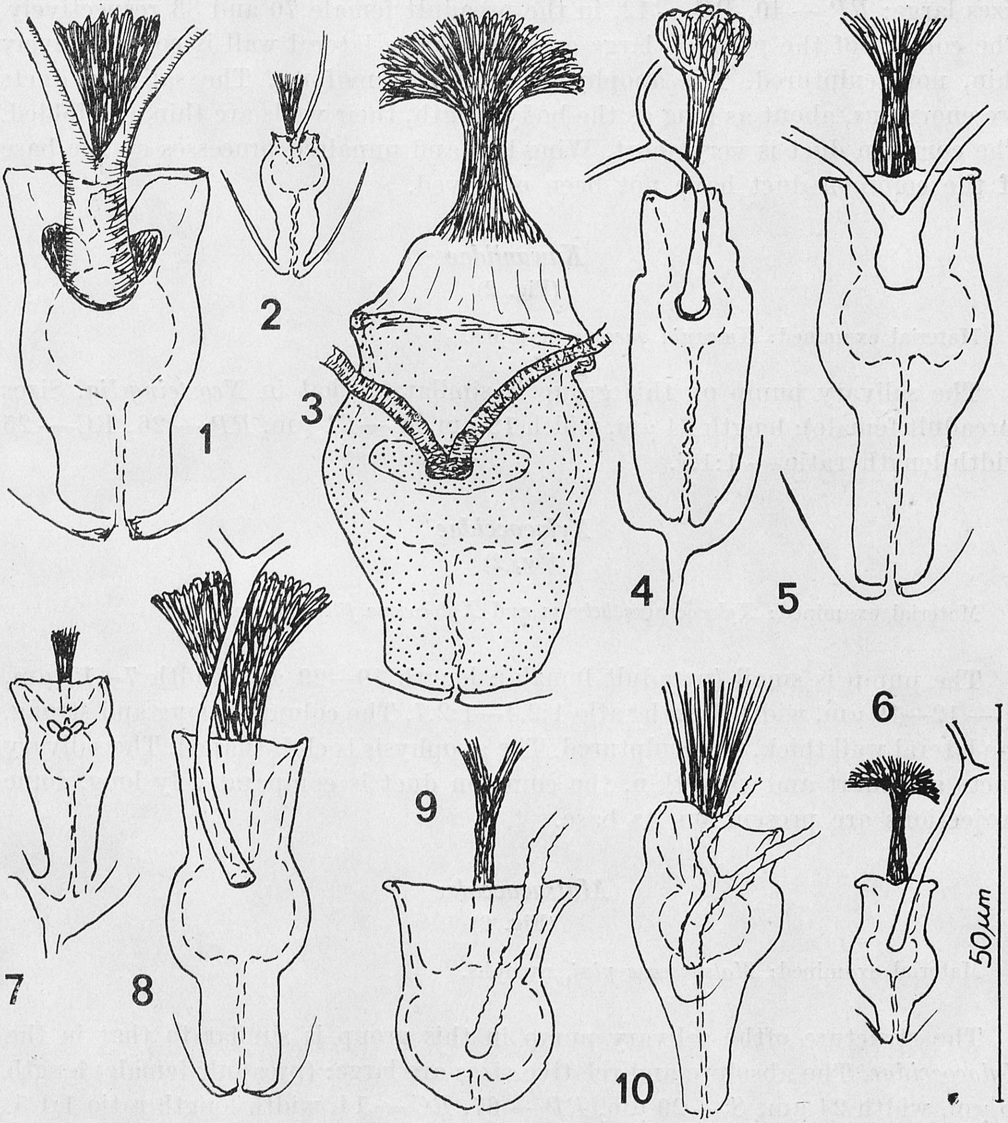


Fig. 2. The salivary pump in the *Orthezioidea*. 1 — *Phenacoleachia zealandica*; 2 — *Newsteadia floccosa*; 3 — *Neosteingelia texana*, preadult female; 4 — *Coelostomidia wairoensis*, preadult female; 5 — *Icerya purchasi*; 6 — id., first stage nymph; 7 — *Xylococcus betulae*, older stage nymph; 8 — *Gigantococcus maximus*, first stage nymph; 9 — *Porphyrophora polonica*, preadult female 10 — *Matsucoccus pini*, preadult female

Neosteingelia group

(Fig. 2)

Material examined: *Neosteingelia texana*, ♀ and nymphs.

The pump is large: length 31 µm, width 24 µm, *S* — 27 µm, in the preadult female respectively — 48 µm, 31 µm, 29 µm, width/length ratio: 1:1.3. Relative

sizes large: *RP* — 40, RC — 12, in the preadult female 70 and 33 respectively The column of the pump is large and short. The lateral wall is comparatively thin, not sculptured. The apophysis is large, fungiform. The salivary ducts are enormous, about as long as the body length, their walls are thin and folded. The common duct is very short. Wing-like and unpaired processes on the base of the common duct have not been observed.

Kuwaniidae
(Fig. 2)

Material examined: *Kuwania quercus*, nymphs.

The salivary pump on this group is similar to that in *Neosteingelia*. Sizes (preadult female): length 24 μm, width 19 μm, *S* — 21 μm, *RP* — 26, RC — 25 width/length ratio — 1:1.7.

Xylococcidae
(Fig. 2)

Material examined: *Xylococculus betulae* and *Xylococcus filiferus*, nymphs.

The pump is small (preadult female): length 19—29 μm, width 7—12 μm, *S* — 12—19 μm, width/length ratio 1:2.4—1:2.7. The column is long and strong, the lateral wall thick, not sculptured. The apophysis is club-shaped. The salivary ducts are short and very thin, the common duct is comparatively long, some projections are present on its base.

Matsucoccidae
(Fig. 2)

Material examined: *Matsucoccus pini*, nymphs.

The structure ofthe salivary pump in this group is similar to that in the *Xylococcidae*. The absolute and relative sizes are large: (preadult female) length 36 μm, width 24 μm, *S* — 29 μm, *RP* — 67, *RC* — 14, width/length ratio 1:1.5. The salivary ducts are longer than is *Xylococcus*, with distinct striation. The common duct is about as long as half the salivery pump. Projections on the base of the duct have not been observed.

Porphyrophoridae
(Fig. 2)

Material examined: *Porphyrophora polonica*, *Dimargarodes mediterraneus*, nymphs.

The pump is medium sized: (preadult female) length and width about 24 μm, *RP* — 37, *RC* — 17. The column is very short, the lateral wall comparatively thin. The apophysis is weak, club-shaped. The salivary ducts are small, the

common duct is long in the first stage nymph, relatively shorter in the preadult female.

Coccoidea

Pseudococcidae

(Fig. 4)

Material examined: *Trabutininae* — 30 species of 20 genera, *Pseudococcinae* — 25 species of 13 genera, *Rhizoecinae* — *Rh. vitis* and *Rh. halophilus*, *Sphaerococcinae* — *S. casuarinae*, *Antonina* (3 species), *Chaetococcus* (2 species).

The salivary pump has an uniform structure in all members of the *Pseudococcidae*. Both absoute and relative sizes are small: length 11—26 (av. 15) μm, width 6—14 (av. 8) μm, *S* — 8—19 (av. 11) μm, *RP* — 16—30, *RC* — 6—10, width/length ratio 1:1.2—1:2.2. In dorsal view the cylinder of the pump is rounded, the lateral wall is thick, not sculptured. The column is strong, about as long as the cylinder or a little shorter. The apophysis is medium sized, funnel shaped. The salivary ducts are thin and short, about as long as half the clypeolabral shield length. The common duct is relatively very long — longer than two lengths of the pump. The wing-like processes are narrow and long. The unpaired-process is large, sometimes deeply bifurcated.

Acanthococcidae

(Fig. 3)

Material examined: 25 species of 7 genera (*Acanthococcus, Phloeococcus, Rhizococcus, Gossyparia, Greenisca, Xerococcus, Eriococcus*).

The salivary pump in this family, excluding *Xerococcus*, is small: length 12—21 (av. 19) μm, width 9—14 (av. 11) μm, *S* — 11—16 (av. 14) μm, *RP* — 27—36, *RC* — 7—11, width/length ratio 1:1.3—1:2.1. The structure of the salivary pump and ducts is similar to that in the *Pseudococcidae*. The wing-like processes are slender and long, being the largest in the whole suborder. The unpaired process is large, sometimes bifurcated apically. Is some species (*Greenisca brachypodii, Acanthococcus greeni*) on the column, ventrally, a scale-like plate has been observed.

In *Xerococcus fouquieriae* the salivary pump differs markedly from that in other *Acanthococcidae*. It is much larger: length 36 μm, width 24 μm, *S* — 29 μm, *RP* — 47, *RC* — 16. The column of the pump is very short.

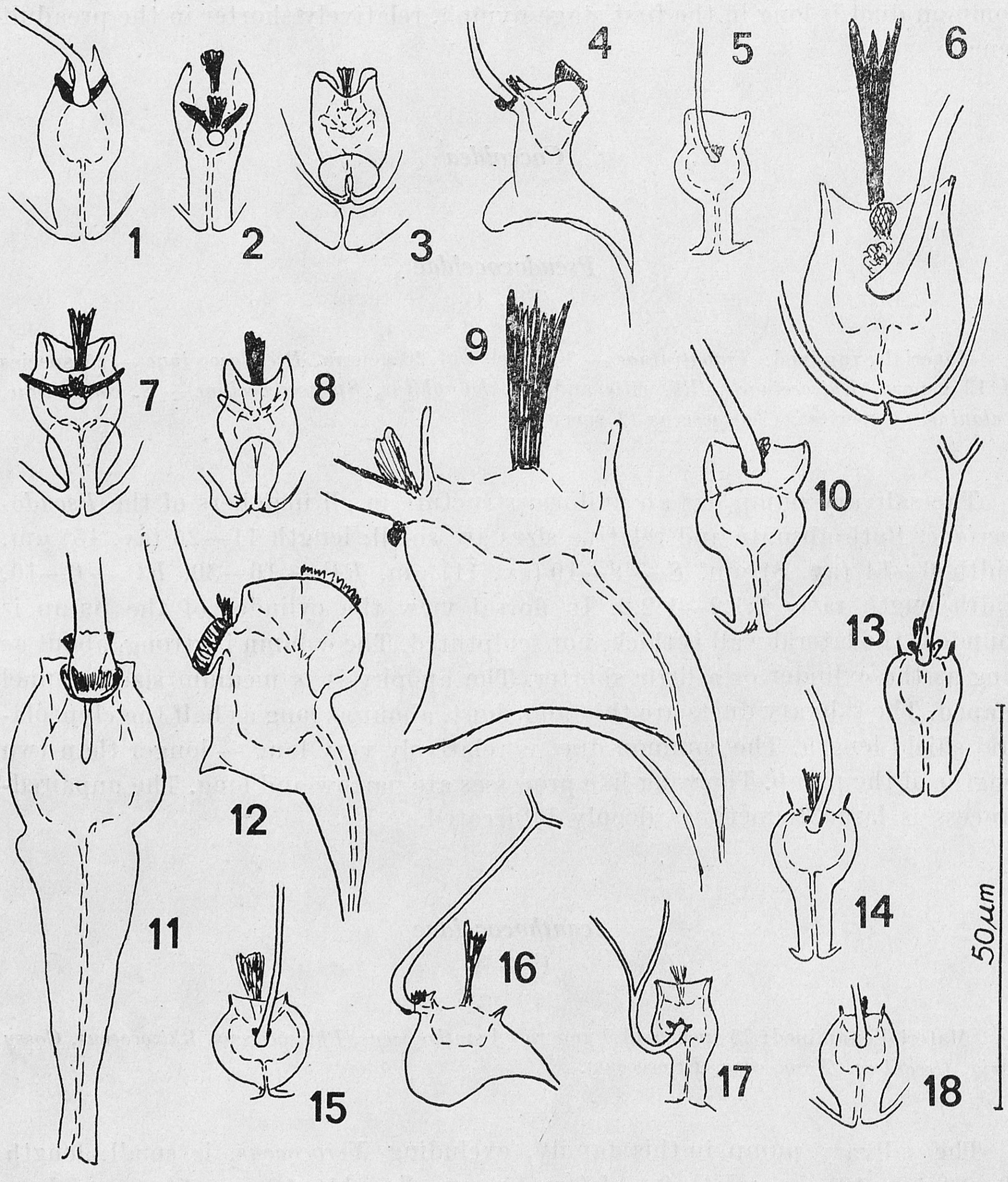


Fig. 3. The salivary pump in the *Acanthococcidae* family group. 1 — *Acanthococcus aceris*; 2 — *Rhizococcus pseudinsignis*; 3 — *Acanthococcus greeni*, ventral view; 4 — *Eriococcus azaleae*, lateral view; 5 — *Phloeococcus loriceus*; 6 — *Xerococcus fouquieriae*; 7 — *Greenisca brachypodii*; 8 — *G. glyceriae*, ventral view; 9 — *Dactylopius* sp., lateral view; 10 — *Apiomorpha* sp., 11 — *Kermes quercus*, dorsal view; 12 — id., lateral view; 13 — *Cerococcus punctiferus*; 14 — *Asterococcus pyri*; 15 — *Kuwanina parva*, dorsal view; 16 — id., lateral view; 17 — *Cryptococcus nudatus*; 18 — *C. fagisuga*

Dactylopiidae

(Fig. 3)

Material examined: 3 species of *Dactylopius.*

The salivary pump in the *Dactylopiidae* is similar to that in the *Acanthococcidae*, but much larger: length 26—38 μm, width 19—34 μm, *S* — 23—36 μm, width/length ratio 1:1.1—1:1.5. The relative sizes of the pump are the same as in the *Acanthococcidae*: *RP* — 19—35, *RC* — 8—10.

Apiomorphidae

(Fig. 3)

Material examined: 3 species of *Apiomorpha.*

The salivary pump in this family is typical of the *Acanthococcidae* family group. Length 17—24 μm, width 12—19 μm, *S* — 14—21 μm, *RP* — 32—39, *RC* — 10—11, width length ratio 1:1.3—1:1.7. The apophysis is very small. The salivary ducts (first stage nymph of *Apiomorpha* sp.) longer than the clypeolabral shield.

Kermesidae

(Fig. 3)

Material examined: *Kermes quercus* and *K. pubescens* (second instar).

The salivary pump in this family is significantly elongate: length 36 μm, width 16 μm, *S* — 24 μm, width/length ratio 1:2.2. Relative sizes: *RP* — 30, *RC* — 14. The column of the pump is narrow, about two times longer than the cylinder. The apophysis is short, enlarged on the apex. The wing-like and unpaired processes are present.

Cerococcidae

(Fig. 3)

Material examined: 5 species of the genera *Cerococcus, Cercococcus, Pollinia* and *Asterococcus.*

The salivary pump in this group is typical of the *Acanthococcidae* family group. The apophysis is small and slender. The dimensions: length 14—17 μm, width 9—12 μm, *S* — 12—14 μm, width/length ratio 1:1.3—1:1.9. Relative sizes: *RP* — 24—30, *RC* — 7—10.

Calycicoccidae

Material examined: *Calycicoccus merwei.*

The structure of the pump in this group seems to be typical of the *Acanthococcidae* family group. The apophysis and the salivary ducts have not been observed in the available specimens. The size: length 17 µm, width 10 µm, *S* — 12 µm, *RC* — 13.

Cryptococcidae

(Fig. 3)

Material examined: *Cryptococcus* (2 species), *Pseudochermes fraxini.*

The pump is typical of the *Acanthococcidae* family group. The common salivary duct is comparatively short — about as long as the pump. The wing-like and unpaired processes are all distinct. The sizes: length 14—15 µm, width 9—10 µm, *S* — 12 µm, *RP* — 32—47, *RC* — about 13, width/length ratio 1:1.4—1:1.5.

***Kuwanina* group**

(Fig. 3)

Material examined: *Kuwanina parva.*

The column of the pump is very short in this group. Other features are similar to those in the *Acanthococcidae* family group. The sizes: length 13 µm, width 12 µm, *RP* — 44, *RC* — 16. The latter number should be emphasized — it is the greatest, beside *Xerococcus*, in the *Acanthococcidae* family group.

Conchaspididae

(Fig. 1)

Material examined: *Conchaspis lata, C. angraeci, Fagisuga trilobata.*

The salivary pump is very large in this group: length 24—36 µm, width 14—24 µm, *S* — 18—29 µm, *RP* — 44—62, *RC* — 16—25, width/length ratio 1:1.2—1:1.7. The column is short, the lateral wall thin, not covered with sculpture. The apophysis is enormous, fungiform. The salivary ducts are thick and long, about as long as half the body length, with their walls irregularly folded. Each of the ducts splits off a short branch in about 1/3 of its length, and then ramifies into about 7 ducts (Fig. 8). This is an anusual feature because in other scale insects only 3 terminal branches have been found. The common duct is short — shorter than half the length of the pump. No wing-like processes or

other similar structures on the base of the common duct have been observed. On the ventral side of the pump a large, scale-like plate occurs.

Stictococcidae

(Fig. 4)

Material examined: *Stictococcus* sp.

The salivary pump in this group is small: length 17 μm, width 10 μm, *S* — 13 μm, *RP* — 28, *RC* — 6, width/length ratio 1:1.7. The column is large and strong, the cylinder is small, rounded, with the lateral wall thick. The apophysis is very weak. The salivary ducts are short and thin, the common duct is much longer than the length of the salivary pump. The processes on the base of the common duct are distinct but very small.

Kerriidae

(Fig. 4)

Material examined: *Kerria lacca, Austrotachardia melaleuca, Tachardiella mexicana.*

The salivary pump is typical of the *Coccidae* family group. Sizes: length 12—21 μm, width 7—12 μm, *S* — 9—14 μm, *RP* — 17—29, *RC* — 7—12, width/length ratio 1:1.4—1:2.1. The column is long and strong, the cylinder small. The apophysis is small, club-shaped. The salivary ducts are thin and short, the common duct is about 3 times as long as the pump. Wing-like and unpaired processes are present.

Coccidae

(Fig. 4)

Material examined: 60 species belonging to 30 genera.

The salivary pump is small in this group: length 10—21 (av. 15) μm, width 5—12 (av. 10) μm, *S* — 7—16 (av. 12) μm, *RP* — 16—30, *RC* — 6—10, width/length ratio 1:1.3—1:2.3. The column is always strong, of various length. The cylinder chamber is rounded, the lateral walls are thick. The apophysis is small and narrow, sometimes divided apically into numerous thin filaments. The salivary ducts are thin and short, the common duct is comparatively long — 2 or more times longer than the salivary pump. The processes on its base are always present, the wing-like processes being sometimes long and slender.

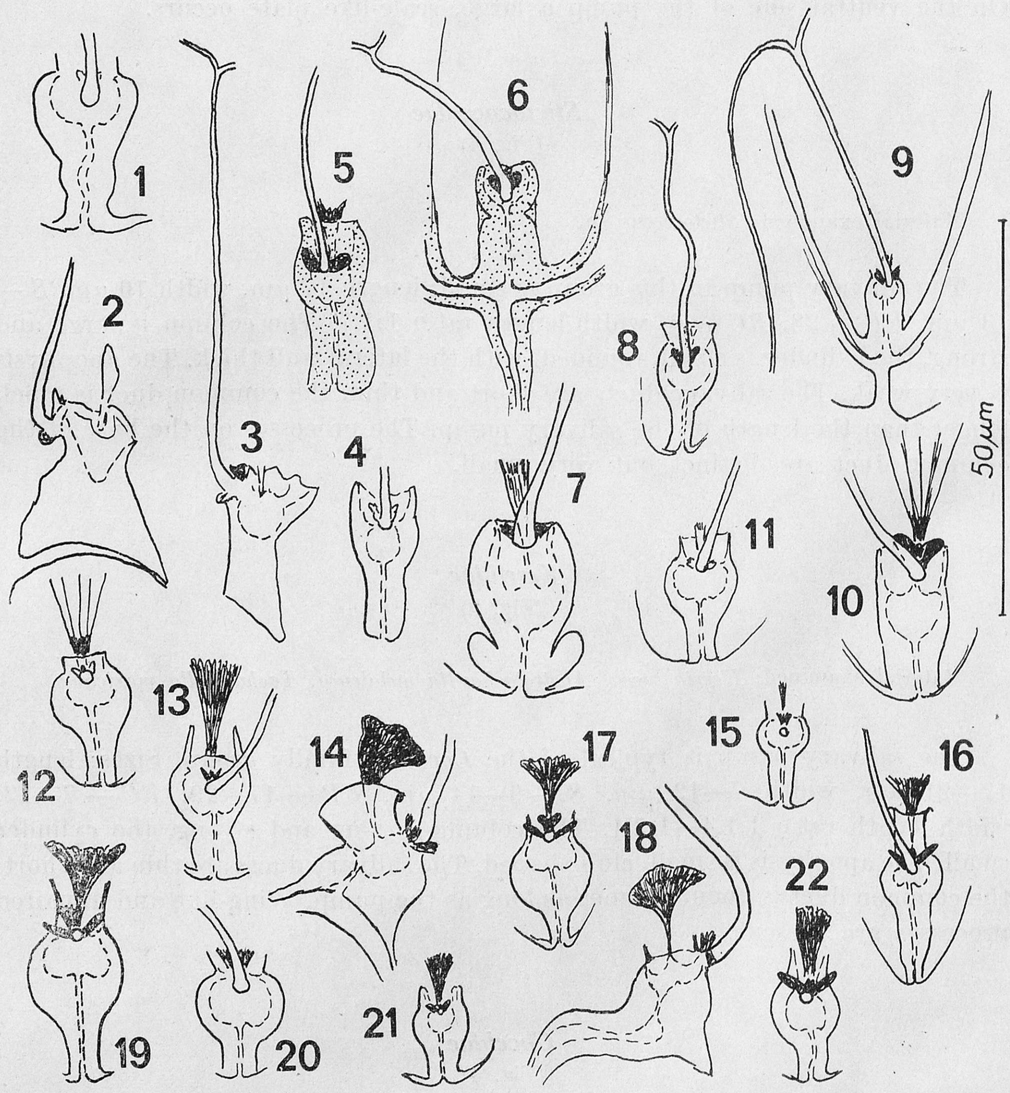


Fig. 4. The salivary pump in the *Pseudococcidae* and *Coccidae* family groups. 1 — *Stictococcus* sp., 2 — *Austrotachardia melaleucae*, lateral view; 3 — *Tachardiella mexicana*, lateral view; 4 — id., dorsal view; 5 — *Kerria lacca*; 6 — *Aclerda xalapenseae*; 7 — *Lecanodiaspis prosopidis*; 8 — *Chloropulvinaria floccifera*; 9 — *Paralecanium milleri*; 10 — *Lecanopsis festucae*; 11 — *Palaeolecanium bituberculatum*; 12 — *Psilococcus parvus*; 13 — *Phenacoccus aceris*; 14 — *Pseudococcus maritimus*, lateral view; 15 — *Rhizoecus halophilus*; 16 — *Atrococcus paludinus*; 17 — *Antonina crawi*, dorsal view; 18 — id., lateral view; 19 — *Trionymus perrisii*; 20 — *Tratina crassispinosa*; 21 — *Rhodania porifera*; 22 — *Mirococcus festucae*

Lecanodiaspididae

(Fig. 4)

Material examined: *Lecanodiaspis prosopidis*, *L. acaciae*, *Prosopophora pasaniae*.

The pump in this group is similar to that in the *Coccidae*. Sizes: length 14—23 μm, width 7—12 μm, *S* — 10—17 μm, *RP* — 18—22, *RC* — 6—7, width/length ratio 1:2.0—1:2.1. The column is very large and strong. The salivary ducts are short and thin, the common duct is long, more than 2 times longer than the salivary pump. The processes on its base are present.

Aclerdidae

(Fig. 4)

Material examined: *Aclerda tokionis*, *A. xalapenseae*, *Nipponaclerda turanica*.

The salivary pump is typical of the *Coccidae* family group. The column is long and slender. The salivary ducts are small. The processes on the base of the common duct are comparatively large. The sizes of the pump: length 10—15 μm, width about 7 μm, *S* — 8—10 μm, *RP* — 15—17, *RC* — 7, width/length ratio 1:1.4—1:2.0.

Cissococcidae

Material examined: *Cissococcus fulleri*.

The structure of the pump in this genus is typical of the *Coccidae* family group. Owing to the unsatisfactory condition of the available specimen the dimensions of the pump could not been measured.

Lachnodius group

Material examined: *Lachnodius eucalypti*.

The salivary pump is comparatively large: length 26 μm, width 26 μm, *RP* — 48, *RC* — 14, width/length ratio 1:1.0. The column is very short. The apophysis is strong, bar-shaped, in the first stage nymph provided with filaments. The salivary ducts are comparatively long and thick. The common duct in the adult female is very short (shorter than half the length of the pump), in the first stage nymph much longer. On the ventral surface of the pump in the first stage nymph there occurs a scale-like plate.

Opisthoscelis group

(Fig. 5)

Material examined: *Opisthoscelis* sp.

The absolute and relative sizes of the salivary pump are very large: length 41 μm, width 45 μm, *S* — 43 μm, *RP* — 81, *RC* — 29, width/length ratio 1:0.9. The column of the pump is very short, the lateral wall is thick, strongly sclerotized, covered with thorn-like sculpture. The apophysis is bar-shaped, branched apically into numerous filaments. The salivary ducts are long and broad. The common duct in the first stage nymph is long — more than 2 lengths of the pump, n the adult female the duct is shorter than 1/2 of the pump length. The processes n the base of the common duct probably exist, but are very small. On the ventral urface of the pump, basally, there occurs a scale-like plate, divided into 2 lobes.

Callococcus group

(Fig. 5)

Material examined: *Callococcus leptospermi*, *C. acaciae.*

The salivary pump in this genus is very large: length 65—77 μm, width 43 μm, *S* — 53—57 μm, *RP* — about 80, *RC* — about 30, width/length ratio 1:1.5—1:1.8. The column is strong, comparatively narrow, in dorsal view heart-shaped. The lateral wall is thick but not sculptured. The apophysis is strong, club-shaped. The salivary ducts are long, broad, with the walls striated. The common duct is about as long as the pump. No processes on its base have been noticed. The scale-like plate on the ventral surface of the pump is divided into 2 lobes.

Beesoniidae

(Fig. 5)

Material examined: *Trichococcus napiformis.*

The salivary pump in this group is medium-sized: length 24 μm, width 19 μm, *S* — 21 μm, *RP* — 29, *RC* — 11, width/length ratio 1:1.3. The column is short, the lateral wall thin, not sculptured, the apophysis is long, bifurcated apically, with filaments. The salivary ducts are of medium length, with their walls striated. The common duct is about as long as the pump. No sclerites occur on the base of the common duct.

Astcrolecaniidae

(Fig. 5)

Material examined: *Mycetococcus ehrhorni*, *Frenchia casurinae* (first stage nymph), *Eremo coccus pirogalis*, *Asterodiaspis variolosa*, *A. bambusae.*

The salivary pump in this not uniform group is medium-sized: length 12—25 μm, width — 14—19 μm, *S* — 10—22 μm, width/length ratio 1:1.0—1:1.3.

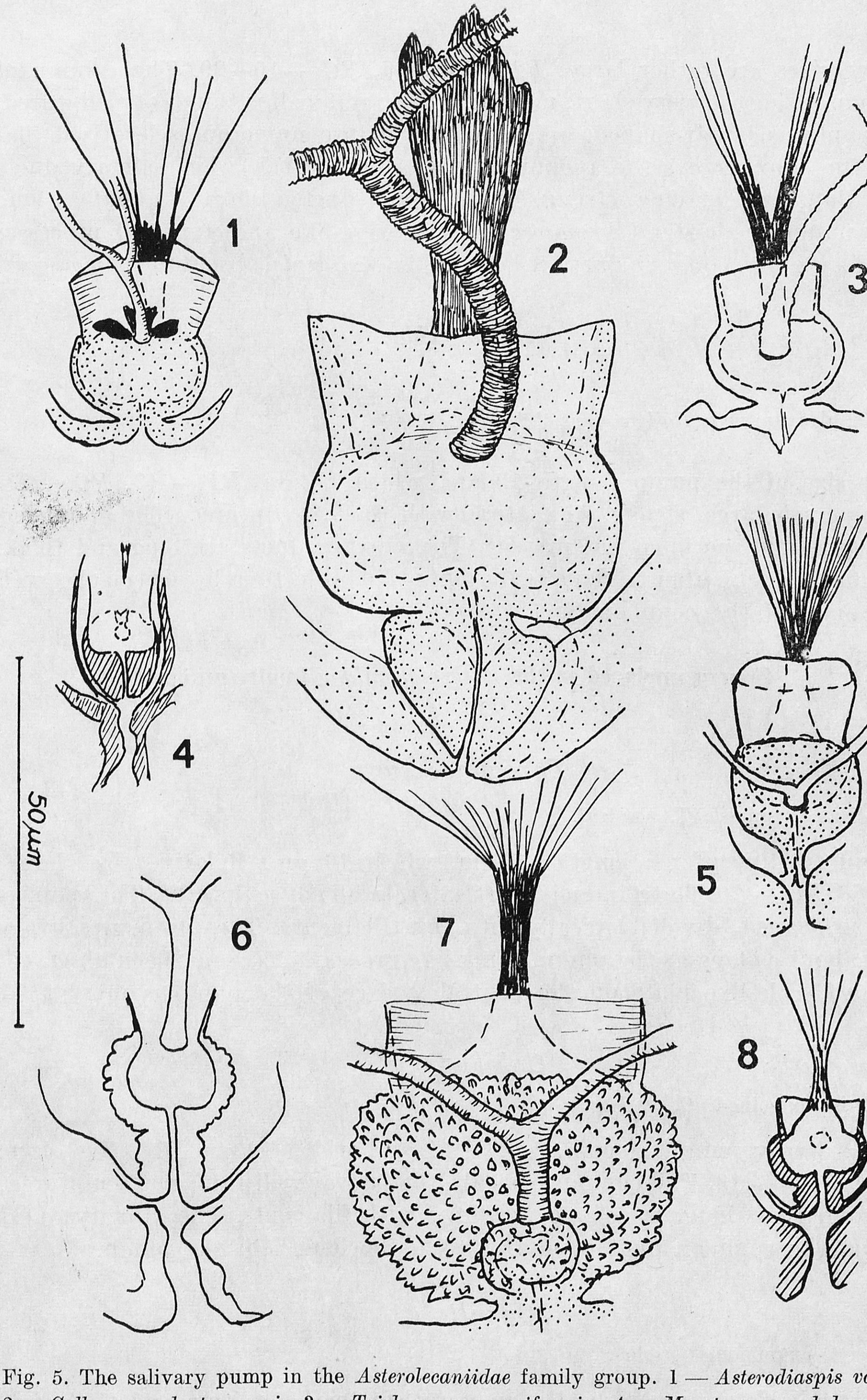


Fig. 5. The salivary pump in the *Asterolecaniidae* family group. 1 — *Asterodiaspis variolosa*; 2 — *Callococcus leptospermi*; 3 — *Trichococcus napiformis*; 4 — *Mycetococcus ehrhorni*; 5 — *Eremococcus pirogalli*; 6 — *Halimococcus thebaicae*; 7 — *Opisthoscelis* sp.; 8 — *Thysanococcus pandani*, longitudinal cross-section

Relative sizes are rather large: *RP* — 25—26, *RC* — 10—29. The column of the pump is short or very short, narrow. The lateral wall is thin, not sculptured. The apophysis is bar-shaped, apically divided into numerous sclerotized filaments (in *Mycetococcus* the apophysis is small and weak). The salivary ducts are medium-sized or long, strong. The common duct is short — about as long as the pump or shorter (*Eremococcus*). The wing-like and unpaired processes on the base of the common duct are large in *Asterodiaspis*, absent in *Eremococcus*.

Halimococcidae

(Fig. 5)

Material examined: *Halimococcus thebaicae.*

The size of the pump: length 19 μm, width 17 μm, *RP* — 42, *RC* — 11. The column is large, strong. The lateral wall thick, sculptured. The apophysis in the available specimen not present. The salivary ducts are long and thick. The common duct is about as long as the pump. No projections have been observed on the base of the common duct.

Genera unplaced in the *Asterolecaniidae* family group

(Fig. 5)

Thysanococcus

Material examined: *T. pandani.*

Absolute dimensions: length 17 μm, width 16 μm. Relative sizes large: *RP* — 63, *RC* — 20. The column is short, lateral wall not sculptured. The apophysis is bar-shaped, divided apically into thin filaments. The common salivary duct is about as long as the pump. Wing-like processes have not been observed. A bilobed scale-like plate on the ventral surface of the pump is present.

Colobopyga

Material examined: *C. attaleae.*

The salivary pump is small: length 14 μm, width 12 μm. Relative sizes: *RP* — 48, *RC* — 13. The column is small, the lateral wall thin, not sculptured. The apophysis is long, bar-shaped, pointed with filaments. The salivary ducts are long, the common duct is shorter than the length of the pump.

Capulinia

Material examined: *C. sallei.*

The available specimen was in an unsatisfactory condition and the pump could not be examined in detail. It is large: length 43 μm, width 41 μm, *RP* —87, *RC* — 25. The column is short, the lateral wall thin. The apophysis has not been

observed. The salivary ducts are large, the common duct is shorter than the length of the pump.

Phoenicococcidae

Material examined: *Phoenicococcus marlatti.*

The salivary pump is large in this group: length 31 μm, width 26 μm, *RP* — 70, *RC* — 19. The column is short. The lateral wall is thick, covered with sculpture. The apophysis is bar-shaped, divided apically into numerous filaments. The salivary ducts are long and broad. The common duct is shorter than 1/2 length of the pump. Wing-like and unpaired processes on the base of the common duct are absent.

Diaspididae

(Figs 6 and 7)

Material examined: 33 species of 28 genera.

The salivary pump is large: length 20—36 (av. 27) μm, width 14—29 (av. 20) μm, *S* — 17—30 (av. 23) μm, width/length ratio 1:1.0—1:1.8. Relative sizes are very large: *RP* — 51—88, *RC* — 15—25. The column of the pump is short or very short, usually broadened medially. The lateral wall is thin or of medium thickness, in the majority of species covered with distinct sculpture. The apophysis is large, club-, or bar-shaped, apically divided into several long filaments. The salivary ducts are long and strong, with their walls sometimes striated. The common duct is as long as the pump, sometimes shorter. In some species the diameter of the common duct is smaller than that in the paired ducts. The wing-like and unpaired projections on the base of the common duct are not developed in this family. The scale-like plate on the ventral side of the pump has been noticed only in *Abamaspis* and *Leucaspis*.

Genera unplaced in the *Diaspididae* family group

(Fig. 7)

Xanthophtalma

Material examined: *X. concinnum.*

The pump in this species is similar to that in the *Diaspididae*. Sizes: length 19 μm, width 11 μm, *S* — 14 μm, width/length ratio 1:1.7. Relative sizes large: *RP* — 56, *RC* — 18.

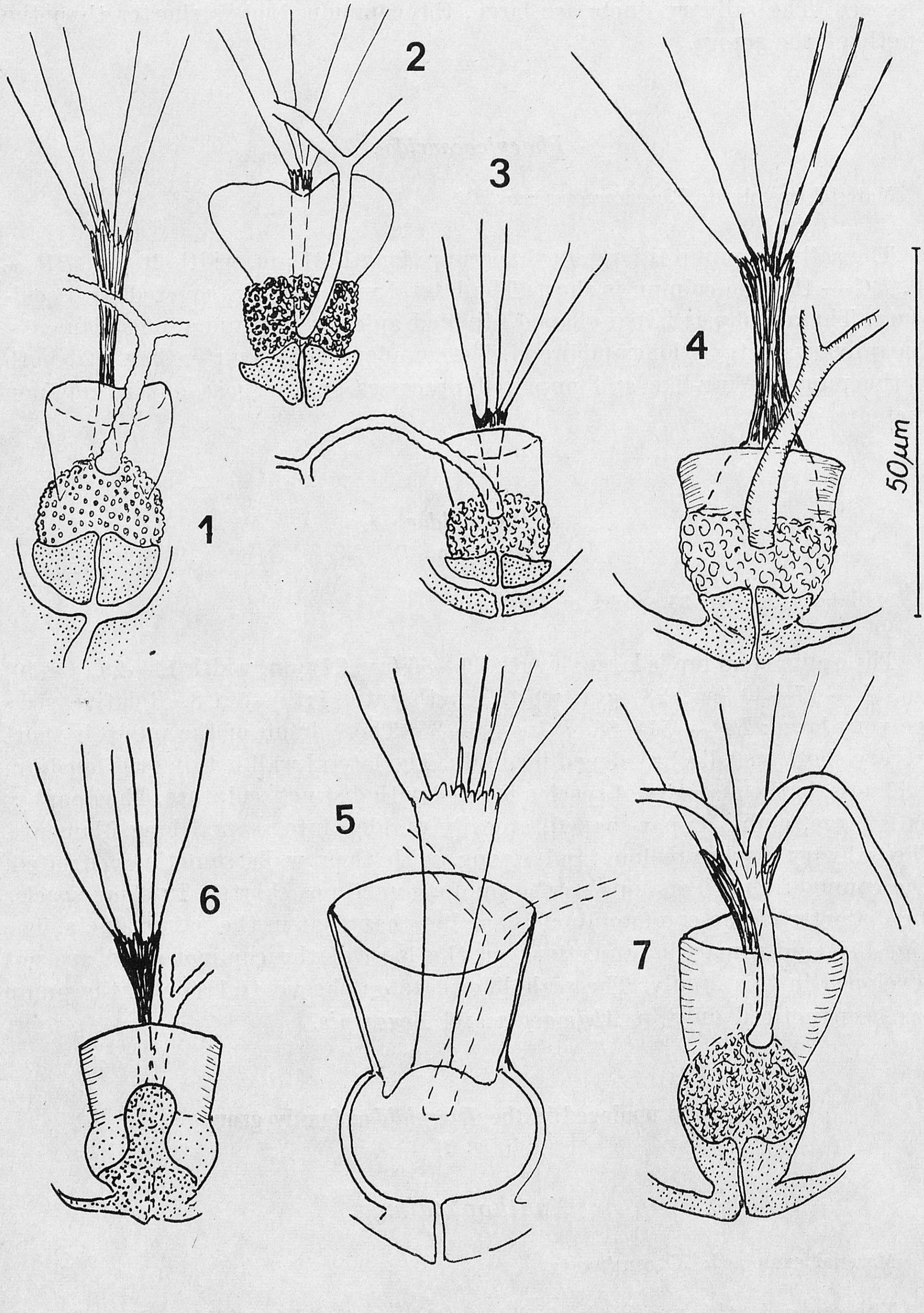


Fig. 6. The salivary pump in the *Diaspididae* family group. 1 — *Lepidosaphes ulmi*; 2 — *Aspidiotus nerii*; 3 — *Carulaspis juniperi*; 4 — *Melanaspis obscura*; 5 — *Maskellia globosa*; 6 — *Anamaspis loewi*, ventral face; 7 — *Leucaspis pini*

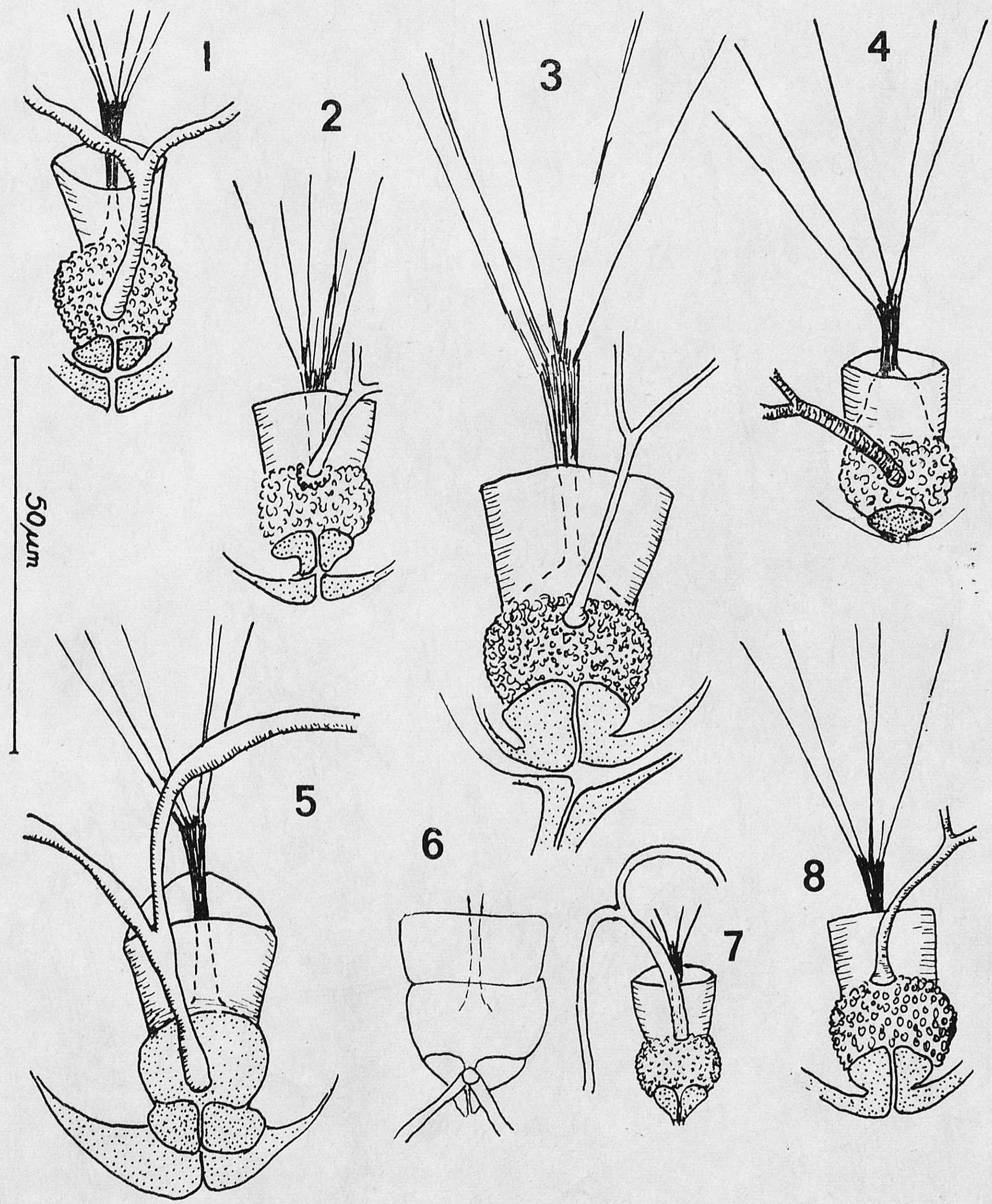


Fig. 7. The salivary pump in the *Diaspiididae* family group. 1 — *Phenacaspis eugeniae*; 2 — *Aulacaspis rosae*; 3 — *Howardia biclavis*; 4 — *Chionaspis salicis*; 5 — *Nuculaspis abietis*; 6 — *Limacoccus brasiliensis*; 7 — *Xanthophtalma concinuum*; 8 — *Niveaspis fenestrata*

Limacoccus

(Fig. 7)

Material examined: *L. brasiliensis*.

The pump is large in this species: 24 µm long, 18 µm wide, width/length ratio 1:1.3, *RP* — 78, *RC* — 11. The column of the pump is short and narrow. The

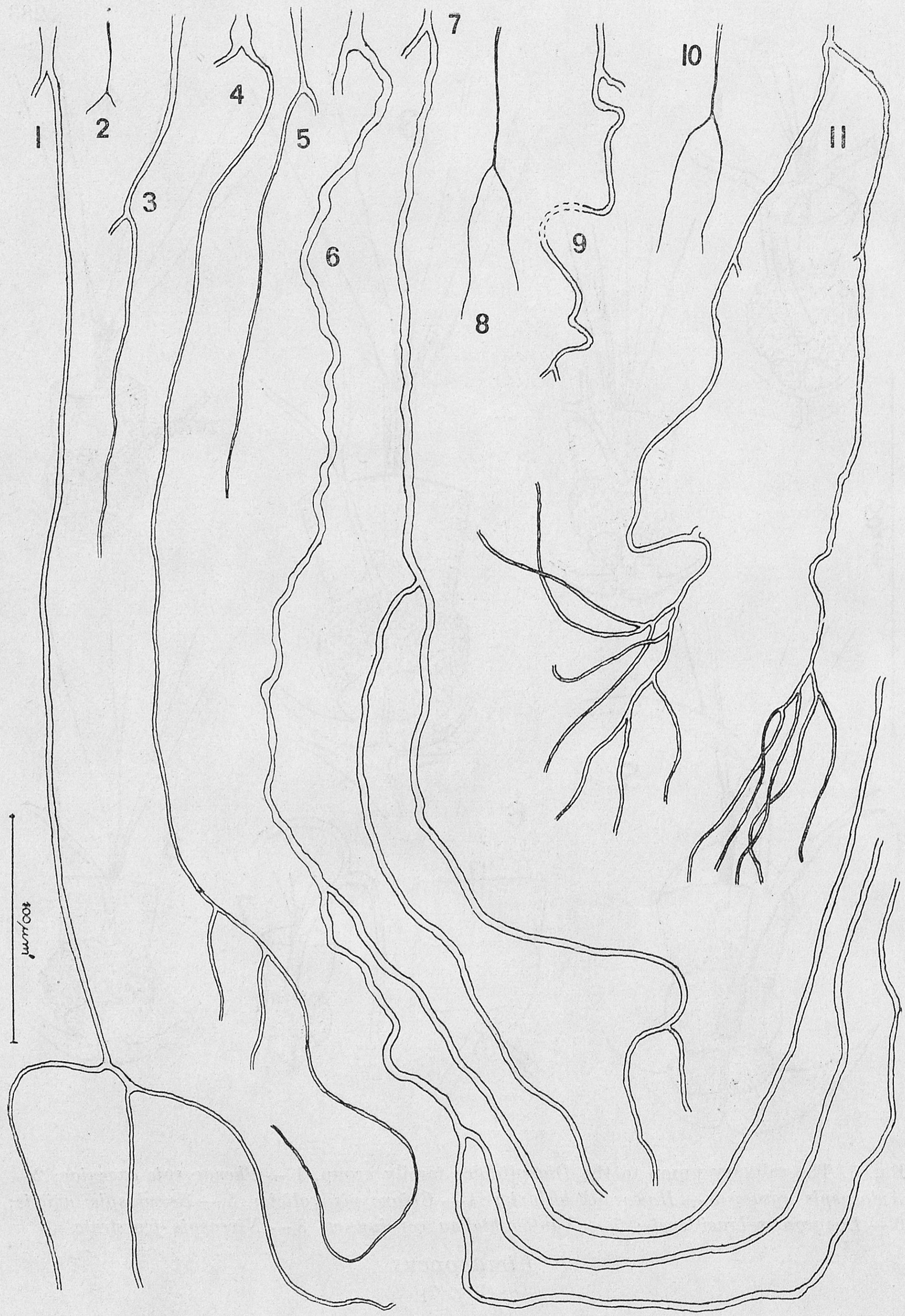


Fig. 8. The salivary ducts. 1 — *Phenacoleachia zealandica*; 2 — *Newsteadia floccosa*; 3 — *Arctorthezia pseudoccidentalis*; 4 — *Icerya purchasi*; 5 — *Coelostomidia wairoensis*, preadult female; 6 — *Neosteingelia texana*, preadult female; 7 — *Kuwania quercus*, preadult female; 8 — *Porphyrophora polonica*, first stage nymph; 9 id., preadult female; 10 — *Xylococculus betulae*, first stage nymph; 11 — *Conchaspis angraeci*

lateral wall is thin, not sculptured. The apophysis is weak, bar-shaped. The salivary ducts are long and broad. The common duct is very short — the paired ducts unite just before reaching the lateral wall of the pump. No projections on the base of the common duct have been observed.

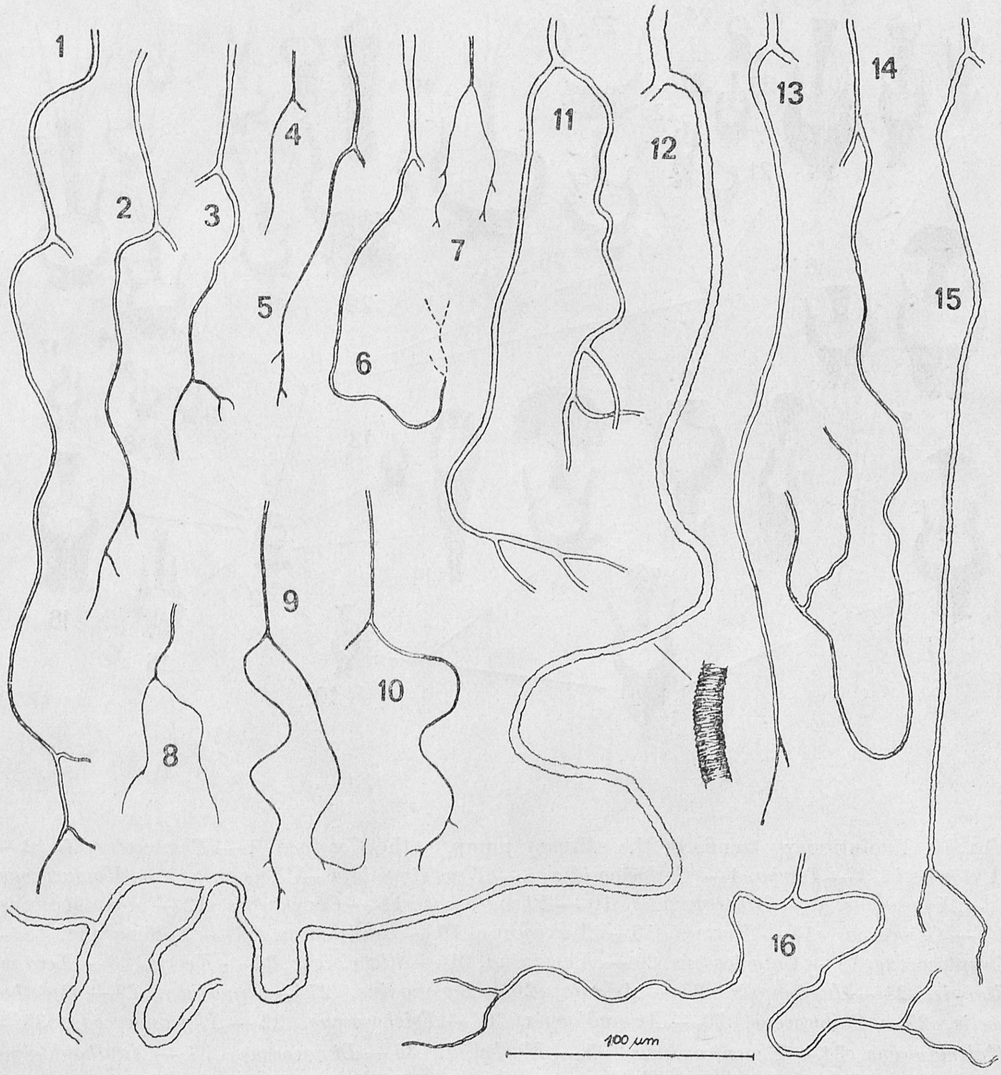


Fig. 9. The salivary ducts. 1 — *Macrocerococcus superbus*; 2 — *Phenacoccus aceris*; 3 — *Pseudococcus maritimus*; 4 — *Rhizoecus vitis*; 5 — *Acanthococcus aceris*; 6 — *Kermes quercus*; 7 — *Kuwanina parva*; 8 — *Chloropulvinaria floccifera*; 9 — *Eulecanium coryli*; 10 — *Lecanodiaspis prosopidis*; 11 — *Asterodiaspis variolosa*; 12 — *Callococcus leptospermi*; 13 — *Opisthoscelis* sp; 14 — *Leucaspis pusilla*; 15 — *Lepidosaphes ulmi*; 16 — *Odonaspis ruthae*

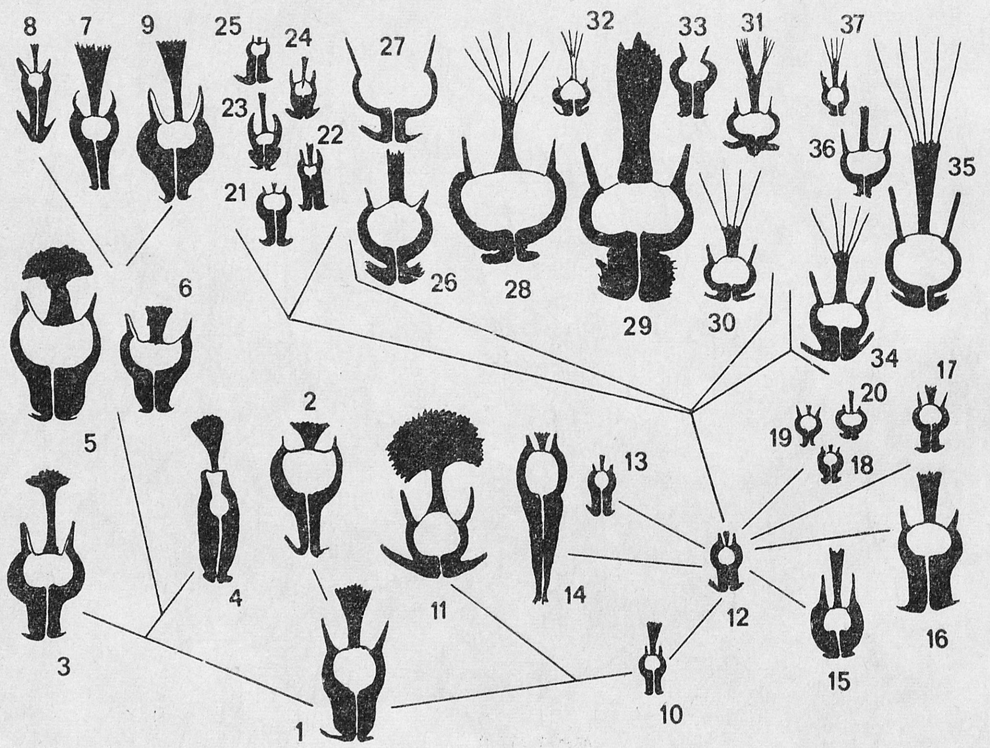


Fig. 10. Evolutionary trends of the salivary pump in the *Coccinea*. 1 — *Phenacoleachia*, 2 — *Arctorthezia*, 3 — *Icerya*, 4 — *Coelostomidia*; 5 — *Neosteingelia*, 6 — *Kuwania*, 7 — *Matsucoccus*, 8 — *Xylococcus*, 9 — *Dimargarodes*, 10 — *Phenacoccus*, 11 — *Conchaspis*, 12 — *Acanthococcus*, 13 — *Cerococcus*, 14 — *Kermes*, 15 — *Xerococcus*, 16 — *Dactylopius*, 17 — *Apiomorpha*, 18 — *Cryptococcus*, 19 — *Calycicoccus*, 20 — *Kuwanina*, 21 — *Stictococcus*, 22 — *Kerria*, 23 — *Lecanodiaspis*, 24 — *Lecanopsis*, 25 — *Aclerda*, 26 — *Lachnodius*, 27 — *Capulinia*, 28 — *Opisthoscelis*, 29 — *Callococcus*, 30 — *Asterodiaspis*, 31 — *Trichococcus*, 32 — *Thysanococcus*, 33 — *Halimococcus*, 34 — *Phoenicococcus*, 35 — *Maskellia*, 36 — *Limacoccus*, 37 — *Xanthophtalma*

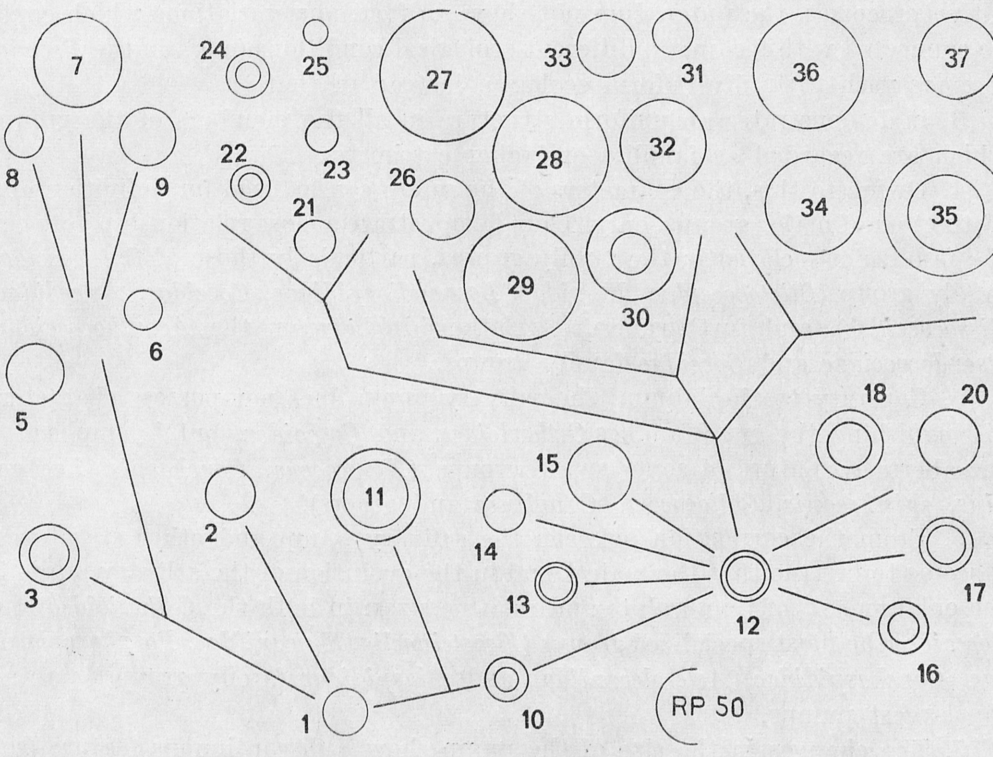


Fig. 11. Changes of the relative size (*RP*) of the salivary pump in the evolution of the *Coccinea*. 1 — *Phenacoleachiidae*, 2 — *Ortheziidae*, 3 — *Monophlebidae*, 5 — *Neosteingelia* group, 6 — *Kuwaniidae*, 7 — *Matsucoccidae*, 8 — *Xylococcidae*, 9 — *Porphyrophoridae*, 10 — *Pseudococcidae*, 11 — *Conchaspididae*, 12 — *Acanthococcidae*, 13 — *Cerococcidae*, 14 — *Kermesidae*, 15 — *Xerococcus*, 16 — *Dactylopiidae*, 17 — *Apiomorphidae*, 18 — *Cryptococcidae*, 20 — *Kuwanina* group, 21 — *Stictococcidae*, 22 — *Kerriidae*, 23 — *Lecanodiaspididae*, 24 — *Coccidae*, 25 — *Aclerdidae*, 26 — *Lachnodius* group, 27 — *Capulinia*, 28 — *Opisthoscelis* group, 29 — *Callococcus* group, 30 — *Asterolecaniidae*, 31 — *Beesoniidae*, 32 — *Thysanococcus*, 33 — *Halimococcus*, 34 — *Phoenicococcidae*, 35 — *Diaspididae*, 36 — *Limacoccus*, 37 — *Xanthophtalma*

CONCLUSIONS

1. The salivary pump represents a simple piece of cuticular skeleton that „bears" a relatively small number of characters which can be utilized in taxonomy.

2. Being closely bound with the feeding and therefore stressed by the adaptative processes, the pump does not show, in fact, any variations which could be connected with feeding in different ecological conditions (e. g., in the *Pseudococcidae* with their diversiform ecology), instead of that

3. it demonstrates an uniform structure in all the members of the groups which are regarded as families or higher categories.

4. Owing to this, the characters of the pump can be used for definition and distinction of major groups, only. They demonstrate a close relationship between the families associated in the family groups, particularly those of the *Coccidae* family group (*Stictococcidae*, *Kerridae*, *Lecanodiaspididae*, *Coccidae*, *Aclerdidae*, *Cissococcidae*), and furthermore, a relationship between the *Acanthococcidae*, *Pseudococcidae* and *Coccidae* family groups.

5. Contrary to the labium, the salivary pump does not possess characters distinguishing the superfamilies *Orthezioidea* and *Coccoidea*, but is emphasizes the aberrative nature of some small groups (*Xerococcus*, *Conchaspis*, *Lachnodius*, *opisthoscelis*, *Callococcus*, *Capulinia* and others).

6. From the correlation between the salivary pump and other structures, it seems to be true that the main trend in the evolution of the salivary pump is the enlargement of its absolute and relative sizes: in both the *Orthezioidea* and *Coccoidea* the most specialized groups (*Neosteingelia*, *Kuwaniidae*, *Porphyrophoridae*, *Conchaspididae*, *Asterolecaniidae* and *Diaspididae* family groups) possess the largest pumps.

7. The changes in the size of the pump show a discontinuous feature (see §§ 2 and 3 above). The significant enlargement of the pump in given groups seems to be connected with some basic changes in the feeding mechanism. This question could be elucidated only through comparative physiological investigations.

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STRESZCZENIE

Badania porównawcze nad szkieletem kutikularnym pompy ślinowej pokazały, że organ ten ma stosunkowo prostą i jednolitą budowę w obrębie wyższych grup czerwców, niezależnie od rośliny żywicielskiej i miejsca żerowania.

Na podstawie uzyskanych danych można sądzić, że w procesie ewolucji zwiększały się bezwzględne i względne wymiary pompy ślinowej. Zmiany te nie mają charakteru ciągłego i, jak się wydaje, pojawiły się skokowo w związku z jakąś nową adaptacją w sposobie pobierania pokarmu i to niezależnie w kilku grupach czerwców. Wyjaśnienie tej adaptacji wymaga porównawczych badań fizjologicznych.

Najprostsza a zarazem najmniejsza pompa występuje u *Phenacoleachiidae*, *Pseudococcidae*, *Acanthococcidae* i grup pokrewnych oraz u wszystkich grup zbliżonych do *Coccidae*, to znaczy u czerwców, które w obecnej faunie stanowią główny jej trzon. Stosunkowo dużą i bardziej skomplikowaną pompę posiadają *Conchaspididae*, *Asterolecaniidae*, *Diaspididae* i niektóre małe grupy (*Xerococcus*, *Lachnodius*, *Opistoscelis*, *Callococcus*), które również pod wieloma innymi względami odbiegają od typowych czerwców wysokim stopniem specjalizacji.

Duża jednolitość budowy pompy oraz mała liczba cech taksonomicznych czynią ją nieprzydatną w systematyce niskich szczebli. Cechy pompy ślinowej pozwalają natomiast na uchwycenie wyższych grup, przede wszystkim grup rodzinowych, oraz uwypuklenie aberatywnego charakteru niektórych małych grup, niekiedy pojedynczych rodzajów, które zwracały na siebie uwagę odrębnością również i innych cech. W przeciwieństwie do ryjka, w pompie ślinowej nie udało się znaleźć cech istotnie różniących dwie główne gałęzie czerwców — *Orthezioidea* i *Coccoidea*.

РЕЗЮМЕ

Сравнительные исследования кутикулярного скелета слюнного насоса доказали, что этот орган имеет сравнительно простое и однородное строение в пределах высших групп червецов, независимо от растения-хозяина и места питания.

На основании полученных данных можно считать, что в процессе эволюции увеличивались абсолютные и относительные размеры слюнного насоса. Эти изменения не имеют постоянного характера и, как кажется, появились скачкообразно в связи с какой-то новой адаптацией в способе получения пищи при том независимо в нескольких группах червецов. Выяснение этой адаптации требует сравнительных физиологических исследований.

Самый простой и самый малый насос имеют *Phenacoleachiidae*, *Pseudococcidae*, *Acanthococcidae* и у родственных групп, а также у всех групп близких *Coccidae*, то есть у червецов, которые в современной фауне составляют её основу. Относительно большой и более сложный насос имеют *Conchaspididae*, *Asterolecaniidae*, *Diaspididae* и некоторые небольшие группы *Xerococcus*, *Lachnodius*, *Opisthoscelis*, *Callococcus*, которые также другими чертами отклоняются от типичных червецов высокой степению специализации.

Большое однообразие строения насоса, а также небольшое количество таксономических черт делают его непригодным в систематике единиц на низшем уровне. Признаки слюнного насоса позволяют поймать высшие группы, прежде всего группы семейств, а также выделить аберративный характер некоторых малых групп, иногда отдельных родов, которые обращали на себя внимание своеобразием также других признаков. В противоположность хоботка в слюнном насосе не обнаружено признаков существенно отличающих двух главных ветвей червецов — *Orthezioidea* и *Coccoidea*.

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